The Patent Office

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed

Dated 14 January 2004

310C 759878-1 C59521
P01/7700 0.00-0225315.1

Patents Form 1/77

Patents Act 1977

The Patent Office

THE PATENT OFFICE
K
31 OCT 2002
NEWPORT

1/77

Request for grant of a patent

Grant

The Patent Office
Concept House
Cardiff Road
Newport
Gwent NP10 8QQ

1.	Your reference	31 OCT 2002 2153-P8013-GB
2.	Patent application number	0225315.1 NEW
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	H M TECHNOLOGY INTERNATIONAL LIMITED Unit 18, Wadsworth Business Centre 21 Wadsworth Road Perivale, Middlesex UB6 7JD United Kingdom
	Patents ADP number *(if you know it)*	
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom 0849594401
4.	Title of the invention	Mechanically Operable Electrical Device
5.	Name of your agent	ATKINSON BURRINGTON
	"Address for service" in the United Kingdom to which all correspondence should be sent	25-29 President Buildings President Way Sheffield S4 7UR GB
	Telephone No:	0114 275 2400
	Patents ADP number	7807043001

		Country	Priority application number *(if you know it)*	Date of filing *(day/month/year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number	N/A	N/A	N/A

		Number of earlier application	Date of filing (day/*month/year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	N/A	N/A

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request?	YES

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	19
Claim(s)	05
Abstract	00
Drawings	15 ~~7~~ 15 R

10. If you are also filing any of the following, state how many against each item.

Priority documents	N/A
Translations of priority documents	N/A
Statement of inventorship and right to grant of a patent (*Patents Form 7/77*)	NONE
Request for preliminary examination and search (*Patents Form 9/77*)	ONE(1)
Request for substantive examination (*Patents Form 10/77*)	NONE
Any other documents (*Please specify*)	

11. I/We request the grant of a patent on the basis of this application.

Signature Date Wednesday, 30 October 2002

12. Name and daytime telephone number of person to contact in the United Kingdom

ALAN G.H. BURRINGTON CPA
0114 275 2400

Mechanically Operable Electrical Device

Background of the Invention

1. Field of the Invention

The present invention relates to a mechanically operable electrical device. In particular, such a device comprising a transmitter electrode, a receiver electrode and a moveable conductive element.

2. Description of the Related Art

Electrical switches comprising of a pair of electrodes which are brought into contact to complete a circuit are well known. A potential problem with some such switches is that repetitive use causes mechanical wear of the electrodes and consequent failure.

In addition, code reading devices are known such that when a coded card to be read is inserted, conductive patches of the card electrically connect selected electrodes of the device to complete electrical circuits. However, due to abrasion by the connecting electrodes, the conductive patches may become worn and lead to incorrect reading of the code.

Brief Summary of the Invention

According to a first aspect of the present invention, there is provided a mechanically operable electrical device, comprising a transmitter electrode, a receiver electrode and a moveable conductive element, wherein: said device is configured such that said conductive element is moveable to a first position remote from said electrodes such that said transmitter electrode is capacitance coupled to said receiver electrode; and said

conductive element is moveable to a second position closer to said electrodes such that said capacitance coupling is reduced.

Brief Description of the Several Views of the Drawings

Figure 1 shows an electrical appliance **101** embodying the present invention;

Figure 2 shows an exploded perspective view of components of the linear array of button switches **101**;

Figures 3A and 3B show a front and rear view of the PCB **206** respectively;

Figures 4A and 4B illustrates the operation of the button switch **102**;

Figure 5 shows a diagram of a circuit used to determine the status of the button switches **102** to **105**;

Figure 6 shows signals which illustrate the operation of the circuit of *Figure 5*;

Figure 7 shows an exploded perspective view of components of the rotary switching device **106**;

Figures 8A and 8B show front and rear views respectively of the PCB **704**;

Figure 9 show an alternative rotary switching device **900**;

Figure 10 shows an electronic apparatus **1001** and a card **1002** used with the apparatus **1001**;

Figure 11 shows the code reader 1008 and the card **1002** of *Figure 10*;

Figures 12 and 13 show the facing surfaces of the printed circuit boards **1120** and **1121** respectively;

Figures 14A and 14B show cross-sectional views of capacitor devices of card reader **1008** which illustrate their operation;

Figure 15 shows a diagram of the electronic circuitry **1501** of card reader **1008**; and

Figure 16 shows an alternative card reading arrangement for the toy **1001**.

Written Description of the Best Mode for Carrying Out the Invention

Figure 1

An electrical appliance **101** embodying the present invention is shown in *Figure 1*. The appliance **100** has a linear array **101** of four manually operable push button switches **102**, **103**, **104** and **105** which allow a user to select functions of the appliance. In addition, the appliance **101** has a rotary switching device **106** which may be manually rotated to one of five positions to allow a further optional selection to be made.

Figure 2

An exploded perspective view of components of the linear array of button switches **101** is shown in *Figure 2*. Each of the four switches **102** to **105** in the array comprises of a button portion, **202**, **203**, **204** and **205** respectively. The button portions are configured to be depressed by finger pressure, and they are subject to spring mechanisms (not shown) which return them to their original positions after being pressed and released. The buttons may also be subject to a mechanism which maintains their position after depression, until they are re-pressed. Such mechanisms are known in the art.

The button portions **202** to **204** are manufactured from an electrically insulating material such as a plastics material. An electrically grounded (earthed) conductive element, made from a rectangular piece of metal, is rigidly attached to the rear side of each button portion. Thus, for example, conductive portion **201** is rigidly attached to the rear surface of button portion **202**.

The linear array **101** of button switches also contains a printed circuit board (PCB) **206**, which defines a capacitor device **212**, **213**, **214**, and **215** for each of the button switches **102** to **105** respectively.

When the button portions are not depressed, the conductive portion **201** is located remotely from the corresponding capacitor device **212**. For example, it may be positioned ten millimetres away. Upon depression of the button portion, the conductive element **201** is relocated to a position relatively near to the capacitor device **212**, for example two millimetres away. The consequential electrical effects on said capacitor device are detected as will be described below.

The conductive element **201** is never brought into contact with electrodes of the capacitor device **212**. To ensure this contact does not take place, the conductive element and/or the electrodes of the capacitor device are covered with an insulating layer, for example, a plastic layer or coating. Alternatively, the movement of the button portion may be mechanically limited to ensure the conductive element cannot make contact upon the PCB.

In an alternative embodiment, the PCB **206** is replaced with a plastic membrane supporting conductive material, such as a conductive ink, defining the capacitance devices and the corresponding tracks providing electrical connections to said devices.

It should be understood that although switch array **101** has been described by way of example to have four button switches, other switch arrays embodying the present invention may be produced with more or less than four such switches. Thus, in the simplest case, the switch array comprises a single button switch.

Figures 3A and 3B

A front and rear view of the PCB **206** is provided by *Figures 3A* and *3B* respectively.

The capacitor devices **212** to **215** each comprise of a transmitter electrode **302, 303, 304** and **305** respectively and a receiver electrode **312, 313, 314, 315** respectively. Each transmitter electrode takes the form of an open circular element which is concentric with a smaller circular element defining the corresponding receiver electrode. Tracks **322** to **325** on the front surface of the PCB provide individual electrical connection to corresponding transmitter electrodes **302** to **305** respectively. The receiving electrodes **312** to **315** are connected to a common track 301 on the rear of the PCB **206** via plated through holes in the PCB. One end of the track **301** terminates in a region **350** of the PCB which supports electronic circuitry for processing signals received by the receiving electrodes.

Hatched areas **351** and **352** on the front and rear of the PCB are electrically grounded. In addition, conductive circular arcs **332** to **335** are arranged concentrically around the capacitor devices **212** to **215** respectively on the front surface of the PCB, and conductive circular arcs **342** to **345** are arranged concentrically around the receiving electrodes **312** to **315** respectively on the rear surface of the PCB. The arcs **342** to **345** and **332** to

335 are also electrically grounded.

The close proximity of the electrically grounded elements **342** to **345** and **332** to **335** ensures that spurious signals received at the receiving electrodes caused by external radiation are kept to within tolerable limits.

Figures 4A and 4B

The operation of the button switch **102** is illustrated in *Figures 4A* and *4B*.

The button switch **102** is shown in the non-pressed configuration in *Figure 4A*. Consequently, the gap between conductive element **201** and the capacitor device **212** is large compared to the relatively small gap of *Figure 4B* where the switch is shown depressed.

During operation of the appliance **101**, a series of square electrical pulses are applied to the transmitter electrode **302** and the resulting signal received at receiving electrode **312** is analysed to determine whether the button switch **102** is depressed or not.

When the moveable conductive element **201** is remote from the device **212**, as shown in *Figure 4A*, the close proximity of the transmitter electrode **302** and the receiver electrode **312** provides sufficient capacitance coupling between said electrodes to allow the signal received at the receiver electrode to be detected. In contrast, when the moveable conductive element **201** is close to the device **212**, as shown in *Figure 4B*, the closeness of said conductive element reduces the capacitance coupling between the transmitter and receiver electrodes such that the received signal is significantly reduced in amplitude.

Example lines of electrical flux **401** and **402**, established during the application of the square pulse to the transmitter electrode **302**, are illustrated in *Figure 4A* and *4B* respectively. The flux lines *401* illustrate how an electric field is generated between the transmitter electrode **302** and receiver electrode **312**, when the button switch is not depressed. Whereas, when it is depressed, the close proximity of the conductive element **201** modifies the electric field such that the flux **402** between the transmitter electrode **302** and the conductive element **201** is increased and that between the transmitter electrode and receiving electrode **312** is correspondingly decreased.

Figure 5

A diagram of a circuit used to determine the status of the button switches **102** to **105** is shown in *Figure 5*. Each of the transmitter electrodes **302** to **305** is connected to a respective low impedance output port OP1, OP2, OP3 and OP4 of a micro-controller **501**. The micro-controller operates under instructions received from read only memory (ROM) **502**. The ROM **502** and the controller **501** may be part of a single application specific integrated circuit (ASIC). The micro-controller is also in communication with an additional memory device, in the form of an EPROM (erasable programmable read only memory) **503**, which may be a plug–in device allowing the operation of the micro-controller to be modified.

The receiving electrodes **312** to **315** of the capacitor devices **212** to **215** are all connected together to the input of analysing electronic circuitry **504**. The circuitry **504** comprises of an amplifier **505**, a bandpass filter **506** configured to filter the output of said amplifier, and a comparator **507**, which takes the output of said filter as its input. The output from the comparator is

connected to an input port, IP1, of the micro-controller **501**.

The micro-controller **501** also has four output ports connected to drive circuitry **508** which generates drive signals in response to the output signals received from the micro-controller. The drive signals may energise actuators, heaters, lights etc. (not shown) in accordance with the type and function of the appliance **101**.

Figure 6

Signals illustrating the operation of the circuit of *Figure 5* are shown in *Figure 6*.

As illustrated by graphs **601** to **604**, the controller **501** sequentially outputs, to the transmitter electrodes **302** to **305**, a square pulse **611** via output port OP1, a square pulse **612** via output port OP2, a square pulse **613** via output port OP3, and then a square pulse **614** via output port OP4. The sequence is then repeatedly repeated.

An example signal received at the receiving electrodes is shown in graph **605** after amplification and filtering by amplifier **505** and filter **506**. The square pulse applied to a transmitter electrode causes charge flow to and from the corresponding receiver electrode. Thus each square pulse generates a positive going pulse **615** to **618** and a negative going pulse **625** to **628** respectively at a receiver electrode.

The filtered signal received at the comparator **507** is compared with a threshold voltage. When the filtered signal is above the threshold voltage a high voltage is supplied to the micro-controller input, and when the filtered signal is below the threshold voltage a low (zero) voltage supplied to the micro-controller input. The graph **606** therefore illustrates the signal received

at the input IP1 from the comparator output.

In the present example, it has been assumed that only button switch **104** has been depressed. Consequently, positive going pulse **617** is below the threshold voltage while the other similar pulses **615**, **616** and **618** are above it. In response, the comparator outputs square pulses **635**, **636** and **638** while the comparator input is above the threshold voltage. It may be noted that, due to the finite rise time of the pulses **615**, **616** and **618**, there is a delay between leading edge of the square pulses **611**, **612** and **614** and the corresponding leading edge of the square pulses **635**, **636** and **638**.

Following the output of a square pulse to one of the transmitter electrodes **302** to **305**, the micro-controller monitors the signal level at the input port IP1 for a subsequent predefined period to determine whether the corresponding switch is depressed. For example, following the output of pulse **611** to switch **102**, the pulse **635** received at input port IP1, indicates to the micro-controller that the button switch **102** is not depressed. Whereas, following the output of pulse **613** the voltage on input port IP1 remains low in the subsequent period and thus the micro-controller determines that the button switch **104** is depressed.

Figure 7

An exploded perspective view of components of the rotary switching device **106** is shown in *Figure 7*. A circular disc **701** is rigidly attached to the manually operable part of the rotary switching device such that it is rotatable about its central axis. The disc **701** has a base made from an insulating material with an electrically grounded conductive region **702** on one of its sides. The disc may thus be made in the manner of a printed circuit board.

The conductive region **702** has a circular portion **703** located off-centre so that as the disc is rotated the portion **703** rotates about the disc's axis.

The side supporting the conductive region **702** is parallel to and closely spaced from a printed circuit board (PCB) **704** such that they share a common central axis. The PCB **704** contains five capacitor devices **711**, **712**, **713**, **714** and **715**, and it is rigidly mounted within the appliance **101**. Consequently, as the disc **701** is rotated it rotates with respect to the PCB **704**, and the conductive portion **703** may be located over each of the five capacitor devices in turn. Preferably, the rotary switching device **106** contains a ratchet mechanism (not shown) so that, when the rotary switching device is rotated and released, the conductive portion **703** is brought to rest directly over a capacitor device.

Figure 8

The PCB **704** is shown in greater detail in the front and rear views of *Figures 8A* and *8B* respectively. Each of the five capacitor devices **711** to **715** have a similar structure to the capacitor devices on PCB **206**. Thus, capacitor device **711** has a small circular receiver electrode **812** surrounded by a transmitter electrode **802**. The transmitter electrode **802** is itself surrounded by an electrically grounded ground electrode **832**. The receiver electrodes of each capacitor device are all connected to a single track **801** via plated through holes in the PCB **704** and tracks **808** on its rear surface.

The rear surface of the PCB **704** has arc shaped ground electrodes **842**, **843**, **844**, **845** and **846**, which are concentric with the capacitor devices **711** to **715** respectively.

As shown in *Figure 8A*, the transmitter electrodes such as electrode **802** form the greater part of a circle but a gap in the circle allows for an extended portion **809** of the ground electrodes, such as electrode **832**, to extend inwards towards the transmitter electrodes, such as **812**. The extended portion of the ground electrodes has a form and position which corresponds to a section of the tracks **808** on the rear side and thus provides additional shielding for the receiver electrodes.

The effect of the conductive region **703** (shown in *Figure 7*) on the capacitor devices **711** to **715** is the same as that of the conductive element **201** on capacitor device **212**. Thus, for example, when the conductive region **703** is rotated to a position which is remote from the capacitor device **711**, the capacitance coupling between the transmitter electrode **802** and the receiver electrode **812** is relatively high and allows a signal applied to the transmitter electrode to be received at the receiver electrode, and, when the conductive region is rotated to a position which is adjacent to said capacitor device, the capacitance coupling is reduced thereby reducing the amplitude of the received signal.

The rotary switching device **106** is incorporated into a similar circuit to that shown in *Figure 5*, whereby a manual selection, made by rotating the conductive region **703** over a particular one of the capacitor devices **711** to **715**, is received.

In an alternative embodiment, a linear switch array, similar to that shown in *Figure 2*, and a rotary switching device, similar to that shown in *Figure 7*, share a single PCB. Thus the features of PBC **206** and PCB **704** are produced on a single PCB. Advantageously, the receiving electrodes of the switch array and the rotary switching device are connected together.

Consequently, the same analysing electronic circuitry and micro-controller may be used to determine selections made at the switch array and the rotary switching device.

Figure 9

An alternative rotary switching device **900** is shown in *Figure 9*. The device **900** uses the same PCB **704** as device **106**. However, the rotatable disc **701** is replaced with an insulating board or sheet **901** which has a fixed location close to, and parallel to, the PCB **704**. For example, in this embodiment the PCB **704** and insulating sheet **901** are separated by 1mm. The sheet **901** is made from a plastics material but in alternative embodiments is made from paper or card. The sheet **901** has five circular regions **902, 903, 904, 905, 906** on its side facing away from the PCB **704**, that are coated with a conducting material. The conductive material may be a conductive ink, such as a carbon ink, a silver ink or transparent conductive ink, or a conductive paint etc. The positions of the conductive regions **902** to **906** correspond to those of the five capacitor devices **711** to **715**, so that they overlay said capacitor devices.

In common with device **106**, device **900** has a rotatable handle **907** allowing manual selection by its rotation. A sprung electrically grounded electrode **908** is rigidly attached to the handle **907**. The ground electrode **908** has smooth connecting portion **909** which presses against the sheet **901** and which may be brought into contact with any one of the five conducting regions **902** to **906** by rotation of the handle **907**.

During operation, the capacitance coupling between the transmitter electrodes and receiver electrodes of each of the capacitor devices **711** to

715 may be reduced by rotating the ground electrode **908** to a position where it electrically grounds the corresponding conductive region **902** to **906** respectively.

Figure 10

An electronic apparatus **1001** and a card **1002** used with the apparatus **1001** is shown in *Figure 10*. In this instance, the electronic apparatus **1001** is an educational toy for a child.

To use the toy **1001** a card such as the card **1002** is inserted into a slot **1003** in said toy. When it is fully inserted, an image **1009** on the card is viewable through a transparent window **1010** in the upper face of the toy. The toy **1001** is provided with an internal spring loaded arm (not shown) which maintains the position of the card within the slot **1003** while it is being used.

After pressing an "ON" button **1004** a child is able to interact with the toy by indicating selected regions of the card **1002** using a stylus **1005**. This is achieved by receiving signals at an electrical receiver located in the stylus tip **1006** that are transmitted by a matrix of linear electrodes within the toy **1001**. Devices having such position detection means are known in the art.

The card **1002** is one of many cards which may be used in co-operation with the toy **1001**. Therefore, in order to operate correctly, the identity of the card **1002** must be provided to the toy **1001**. For this reason, the card **1002** has an identifying code **1007** arranged along an end portion of the card, and the toy **1001** has code reader **1008**. The code reader 1008 receives the end portion of an inserted card and identifies it from the identifying code **1007**.

The toy **1001** and card **1002** provide an example of the present invention. However, it should be understood that other portable objects supporting code defined by conductive elements may be used with code reading apparatus operating in accordance with the present invention. For example, the code reading apparatus may form part of a security device, such as a door lock, requiring the insertion of a card having a particular code in order to be activated.

Figure 11

The code reader **1008** and the card **1002** of *Figure 10* are shown in *Figure 11*. The identifying code **1007** comprises of a series of conductive pads linearly arranged adjacent the edge **1101** of the card **1002**. Cards, such as card **1002**, have eight regions **1111** to **1118** inclusive, reserved for the possible application of a conductive pad. One or more of the conductive pads are applied to the card as conductive ink, or paint, during their production. Preferably, the card is subsequently laminated or coated with an insulating protective layer of, for example, a plastics material. (The protective layer **1400** is shown in *Figures 14A* and *14B*). Thus the ink is protected from abrasion during use.

The cards, such as card **1002**, are individually identifiable by the presence or absence of conductive ink in each of the reserved regions **1111** to **1118**. For example, the pattern of the conductive pads may be considered to define a binary code number which identifies the card. For example, card **1002** has a conductive pad at regions **1111**, **1113**, **1116**, **1117** and **1118** while regions **1112**, **1114** and **1115** are devoid of conductive material. Thus, the conductive pads on card **1002** define the binary number 10100111, or

167 in base ten. In this way, using eight reserved regions and at least one conductive pad on each card, two hundred and fifty-five different cards may be identified. Alternatively, the cards may have different images on each of their faces so that they may be used either way up. In this case, each face of the card is identified by the identifying code **1007**. For example, if card **1002** were turned up side down and edge **1101** inserted into card reader **1008**, it would present the binary number 11100101 (two hundred and twenty-nine in base ten) to the card reader. i.e. the reverse of binary number 10100111. Thus, the two faces of the card are individually represented by a single identifying code.

The card reader **1008** comprises of two printed circuit boards **1120** and **1121** spaced apart by spacers **1122**. The gap between the PCB **1120** and the PCB **1121** is sufficiently wide to provide a loose fit for the end portion of cards, such as card **1002**. Typically, the gap is between two millimetres to five millimetres wide, and preferably it is two millimetres to three millimetres wide. The upper surface **1123** of PCB **1120** is conductive and electrically grounded to provide shielding for receiver electrodes located on it lower surface.

Transmitter electrodes are located on the upper surface of the PCB **1121**, and in combination with the receiver electrodes they define eight capacitor devices. Each capacitor device is positioned to receive one of the reserved regions **1111** to **1118** when a card is inserted. The reduction of conductance coupling in one of said capacitor devices, caused by the presence of a conductive pad, allows the card reader **1008** to determine its presence.

Figures 12 and 13

The facing surfaces of the printed circuit boards **1120** and **1121** are shown in *Figures 12* and *13* respectively. PCB **1120** has eight circular receiver electrodes **1201** to **1208** inclusive, which are linearly aligned and equally spaced. The PCB also supports signal analysing circuitry within a region **1210**, and all the receiving electrodes **1201** to **1208** are connected to said circuitry by a single conductive track **1209**. A grounded electrode **1211** (shown hatched) surrounds the receiving electrodes **1201** to **1208** and the conductive track **1209**, to provide further shielding for the receiving electrodes from electromagnetic noise.

As shown in *Figure 13*, the upper surface of PCB **1121** has eight square shaped transmitter electrodes **1301** to **1308** inclusive. The eight transmitter electrodes are positioned such that they face the receiver electrodes **1201** to **1208** when the card reader **1123** is assembled. The transmitter electrodes are connected to terminals **1309** by plated through holes in their centres and conductive tracks on the reverse side of the PCB **1121** (illustrated by dashed lines **1310**). A ground electrode **1311** surrounds the transmitter electrodes to provide further screening from electromagnetic noise.

Figure 14A and 14B

The operation of capacitor devices of card reader **1008** is illustrated in the cross-sectional views of *Figures 14A* and *14B*. *Figure 14A* shows the capacitor device defined by transmitting electrode **1302** and receiving electrode **1202** while reading card **1002**. In operation, a square pulse is

applied to the transmitter electrode **1302** via a conductive track **1310**. In the absence of a conductive pad, the capacitance coupling between said electrodes remains relatively high, and consequently a relatively high signal is received at receiving electrode **1202**.

Figure 14B shows the capacitor device defined by transmitting electrode **1303** and receiving electrode **1203** while reading the same card, **1002**. In this instance, a conductive pad **1401** is present between said electrodes and, consequently, the capacitance coupling between them is reduced to a relatively low value. Therefore, when a square pulse is applied to the transmitter electrode **1303**, the presence of the conductive pad **1401** causes a relatively low signal to be received at receiving electrode **1203**.

Thus, by supplying a square pulse to each of the transmitting electrodes **1301** to **1308** in turn, and monitoring the amplitude of the pulse received at receiving electrodes, it is possible to determine the identifying code on the currently inserted card.

Figure 15

A diagram of the electronic circuitry **1501** of card reader **1008** is shown in *Figure 15*. Many of the components of circuit **1500** are the same as those of *Figure 5* and operate in a similar manner. Thus, circuit **1500** has a micro-controller **1501**, in communication with a ROM **1502** and an EPROM **1503**. The EPROM **1503** may be configured to be replaceable, so that a particular EPROM which is designed for use with a particular set of cards may be used.

The micro-controller **1501** also receives digital signals from analysing electronic circuitry **1504**, itself comprising an amplifier **1505**, a bandpass filter

1506 configured to filter the output of said amplifier, and a comparator **1507**.

Eight output ports of the micro-controller **1501** are each connected to one of the transmitter electrodes **1301** to **1308**. The receiving electrode **1201** to **1208** are all connected to a single input of amplifier **1505**.

A ninth output port of micro-controller **1501** is connected to amplifier **1510** which provides signals to an audio speaker **1511**. Thus, in response to the identification of a card, signals relating to the card are supplied to the amplifier **1501** in accordance with data stored in EPROM **1503**.

The operation of the circuit **1500** is essentially the same as the circuit of *Figure 5*. Thus, the micro-controller **1501** supplies a square pulse to each transmitter electrode **1301** to **1308** in turn, and in a following period, it monitors the signal received from comparator **1507**. Signals received by receiving electrodes are amplified by amplifier **1505** before being filtered by bandpass filter **1506**. The comparator **1507** determines whether the signal goes above a threshold value, and if so then a high output is supplied to microprocessor **1501**. Consequently, the micro-controller is able to determine the presence or absence of a conductive pad in each of the regions **1111** to **1118** of a card, and thus determine the identity of said card.

Figure 16

An alternative card reading arrangement for the toy **1001** is illustrated by *Figure 16*. A PCB **1601** has essentially the same structure as PCB **1120** except that it contains ten receiving electrodes, instead of eight. However, unlike the card reader **1008**, the corresponding transmitting electrodes **1603** are printed onto a flexible plastic membrane **1602**. As well as forming a part of the card reading arrangement, the plastic membrane supports the matrix

of linear conductors which are used in co-operation with the stylus **1006** to provide an X-Y position sensing device.

Thus when a card is initially inserted, or the toy is first switched on, signals are supplied via the linear conductors to the transmitter electrodes to identify the card. Having identified the card the matrix is then used in the position sensing mode.

In a further alternative card reading arrangement for the toy **1001**, the PCB **1601** is replaced with an extended portion of plastic membrane **1602**. Receiving electrodes are printed onto the extended portion, and the membrane is folded such that each of the receiving electrodes is positioned opposite one of the transmitting electrodes **1603**. The membrane is folded such that a suitable gap is provided between the receiving electrodes and transmitting electrodes for receiving a card such as card **1002**. This alternative arrangement operates in the same manner as those of *Figure 10*, or *Figure 16*, but has the advantage of not requiring a PCB to provide the transmitting and receiving electrodes.

The receiving electrodes and transmitting electrodes are separated by a gap produced by the folding.

Claims

1. A mechanically operable electrical device, comprising a transmitter electrode, a receiver electrode and a moveable conductive element, wherein:

said device is configured such that said conductive element is moveable to a first position remote from said electrodes such that said transmitter electrode is capacitance coupled to said receiver electrode; and

said conductive element is moveable to a second position closer to said electrodes such that said capacitance coupling is reduced.

2. A mechanically operable electrical device according to claim 1, wherein said device comprises a ground electrode which is grounded in use to electromagnetically shield said receiving electrode.

3. A mechanically operable electrical device according to claim 1 or claim 2, wherein said conductive element is continuously grounded during use.

4. A mechanically operable electrical device according to any of claims 1 to 3, wherein said transmitter electrode and said receiver electrode are located in the same plane.

5. A mechanically operable electrical device according to any of claims 1 or 2, wherein said conductive element is not electrically connected.

6. A mechanically operable electrical device according to any of claims **1** to **3** or claim **5**, wherein said receiving electrode is positioned on a separate parallel plane to said transmitting electrode.

7. A mechanically operable electrical device according to any of claims **1** to **3** or claim **5** or **6**, wherein said conductive element in said second position is located between said transmitter electrode and said receiver electrode.

8. A mechanically operable electrical device according to any of claims **1** to **7** wherein said transmitter electrode is formed on a printed circuit board.

9. A mechanically operable electrical device according to claim **8**, wherein said printed circuit board is a membrane which forms part of a position sensing device.

10. A mechanically operable electrical device according to any of claims **1** to **9**, wherein said transmitter electrode and receiver electrode are one of a plurality of such pairs of transmitter electrodes and corresponding receiver electrodes; said conductive element is one of a number of conductive elements located on a portable object to define an identifying code; and said portable object is configured to be manually inserted between said transmitter electrodes and said receiver electrodes, whereby the capacitance coupling between each transmitting electrode and the

corresponding receiver electrode depends upon the presence of a conductive element on said portable object.

11. A mechanically operable electrical device according to any of claims **1** to **4**, wherein said device is configured as a manually operable switch.

12. A mechanically operable electrical device according to claim **11**, wherein said device further comprises one or more additional pairs of transmitter electrodes and receiver electrodes, and said conductive element is moveable by rotation to other positions in which it is closer to one of said pairs of electrodes.

13. Code reading apparatus, and a coded object having one or more conductive regions at defined locations to define a code, wherein said device comprises:

a plurality of capacitor devices each having a transmitter electrode and a capacitance coupled receiver electrode;

a signal generating device configured to supply a signal of a predetermined type to each said transmitter electrode; and

a signal analysing means for analysing a received signal received by said receiving electrodes,

wherein said code reading device is configured to receive said one or more conductive regions of said coded object such that the capacitance coupling between the electrodes of one or more corresponding capacitor devices is modified, whereby the signal received at one or more

corresponding receiving electrodes is modified.

14. Code reading apparatus according to claim **13**, wherein said coded object is a card.

15. Code reading apparatus according to claim **13** or claim **14**, wherein said code reading apparatus is a toy and said coded object is one of a plurality of coded cards, each card being individually identified by conductive regions defining a code.

16. Code reading apparatus according to claim **15**, wherein said card has images on each of its faces, and said apparatus is configured to identify the displayed face from said code.

17. Code reading apparatus according to claim **13** or claim **14**, wherein said code reading apparatus forms part of security apparatus.

18. A mechanically operable electrical device, comprising a transmitter electrode; a receiver electrode capacitance coupled to said transmitter electrode; a conductive element adjacent to said transmitter electrode and said receiver electrode; and a ground electrode, wherein

said ground electrode is moveable between:

(a) a first position in which said conductive element is not electrically grounded such that capacitance coupling between said transmitter electrode and said receiver electrode is relatively high; and

(b) a second position in which said conductive element is electrically grounded whereby said capacitance coupling is reduced.

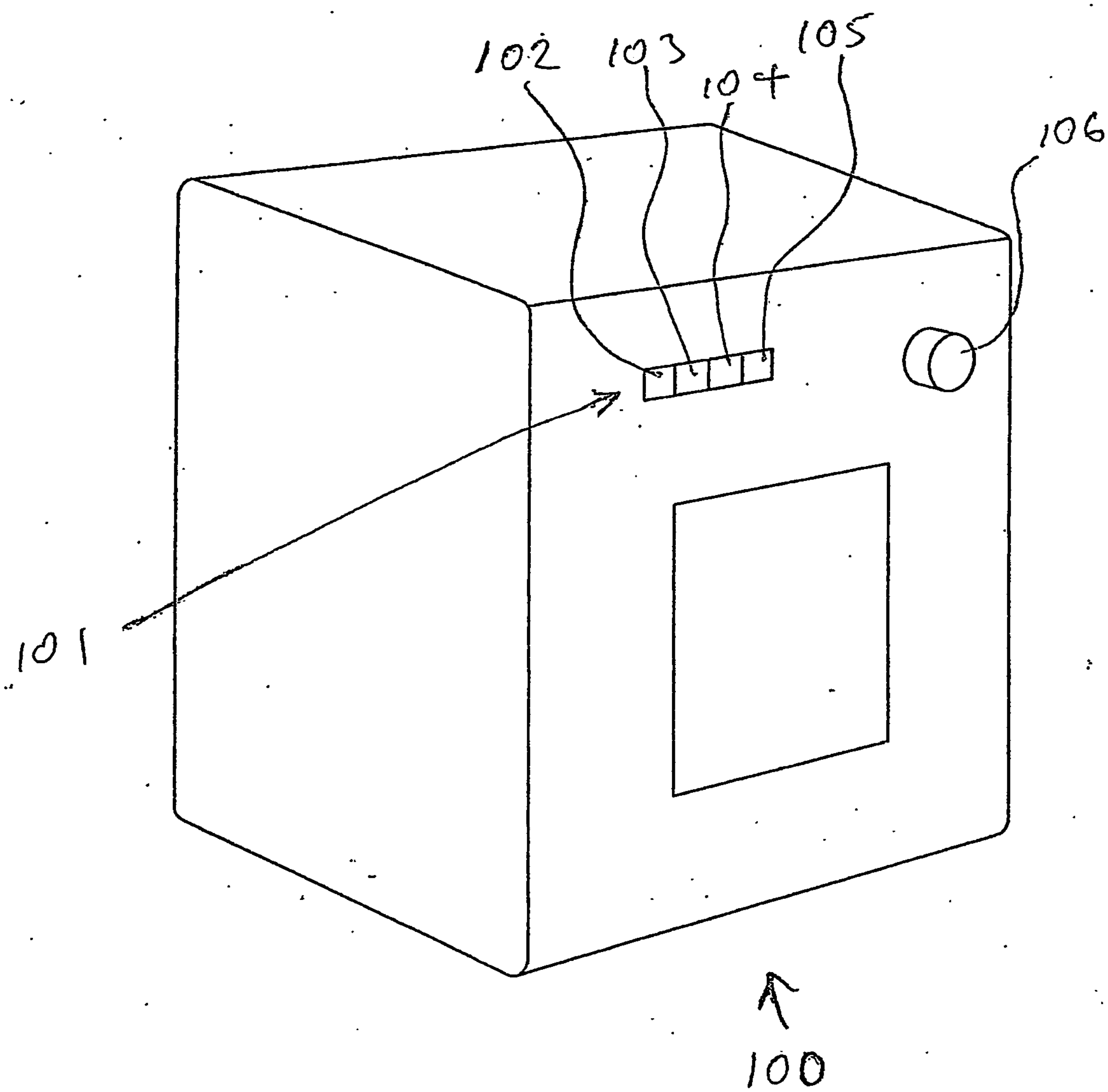


Fig. 1

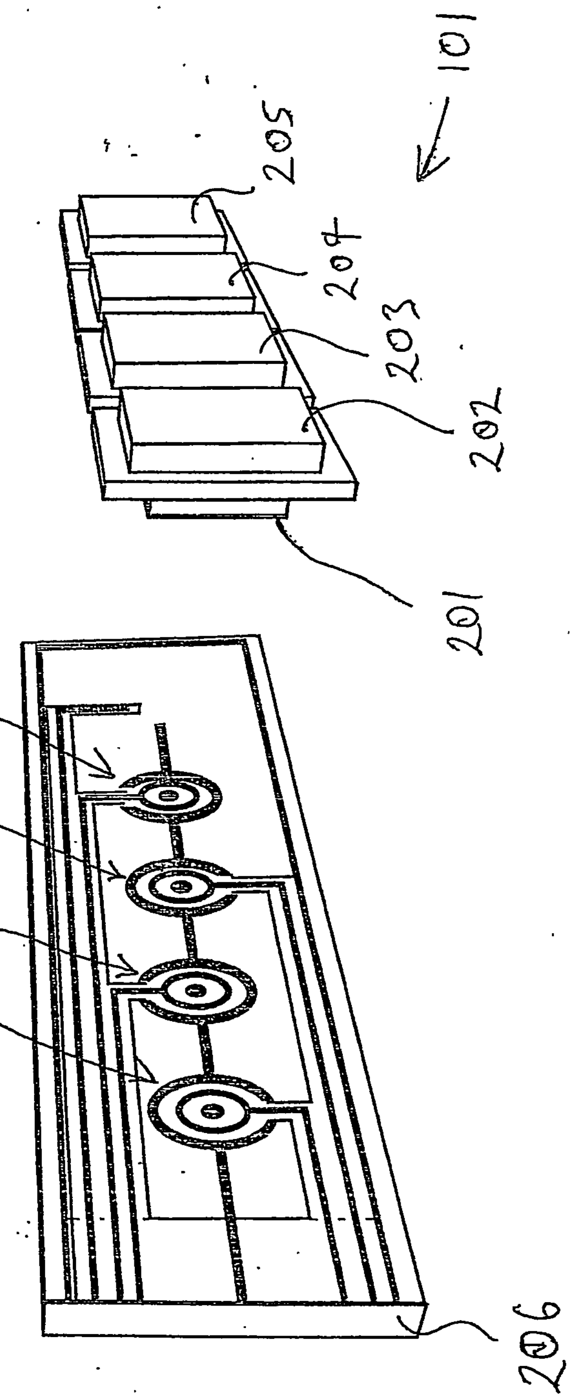


Fig. 2

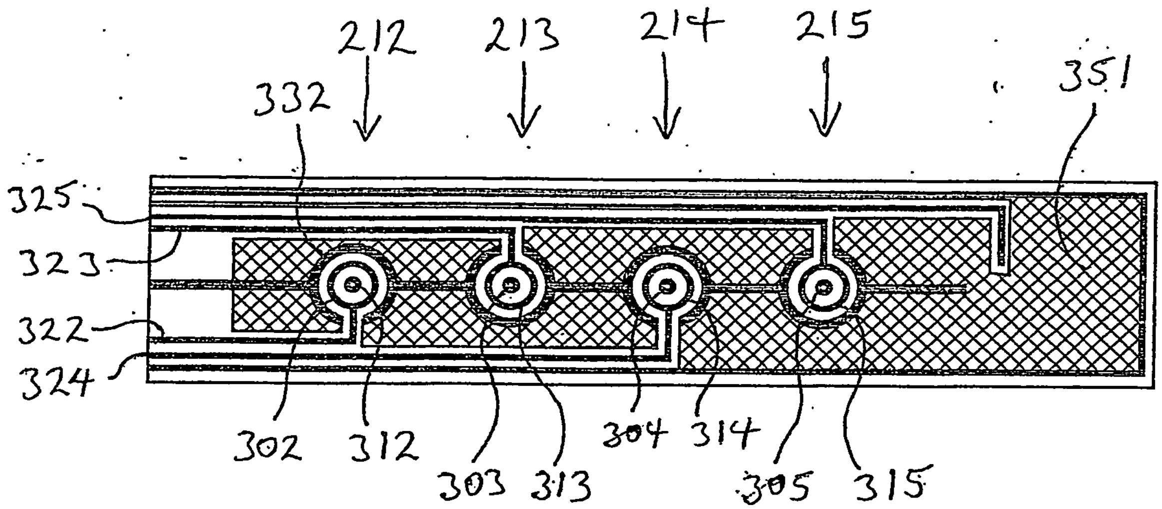

212
213
214
215
351
332
325
323
322
324
302
312
303
313
304
314
305
315

Fig. 3A

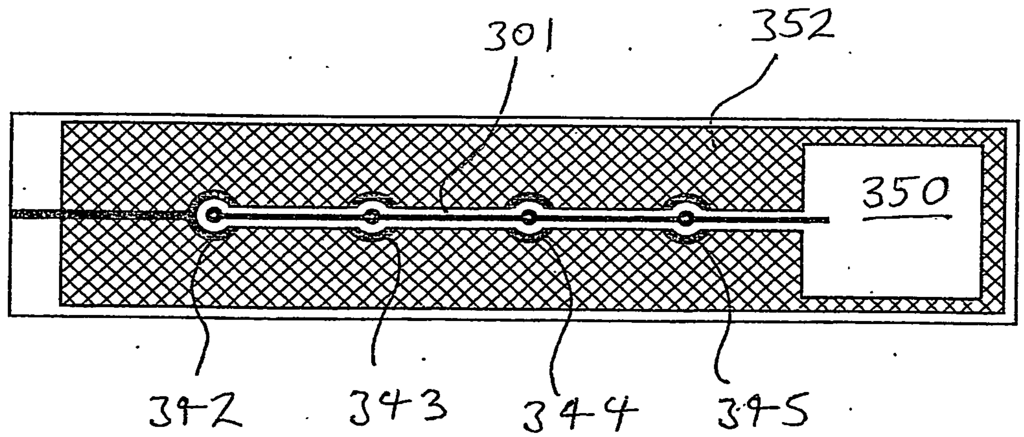

301
352
350
342
343
344
345

Fig. 3B

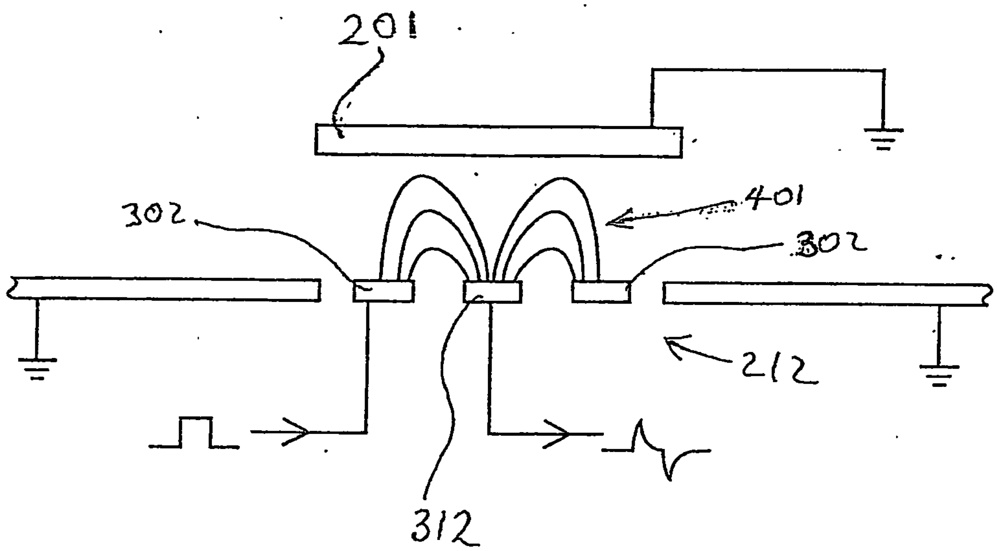


Fig. 4A

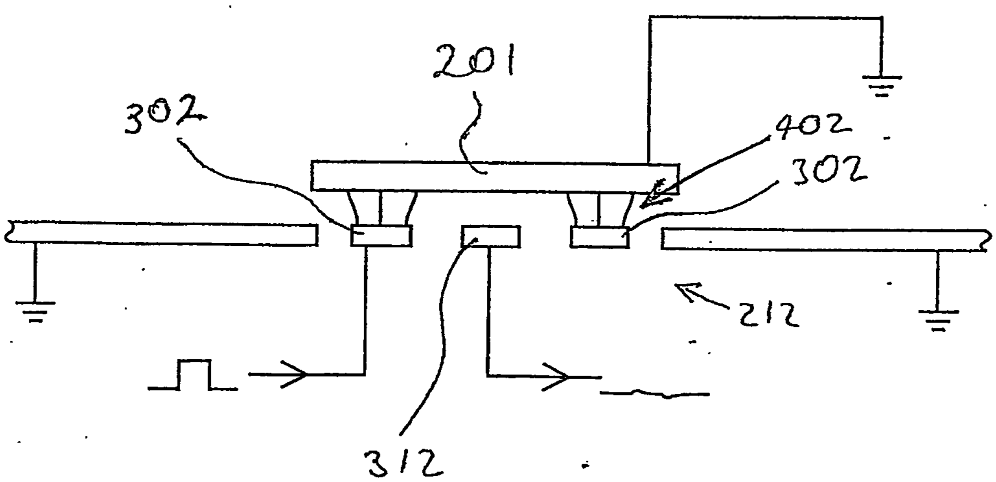


Fig. 4B

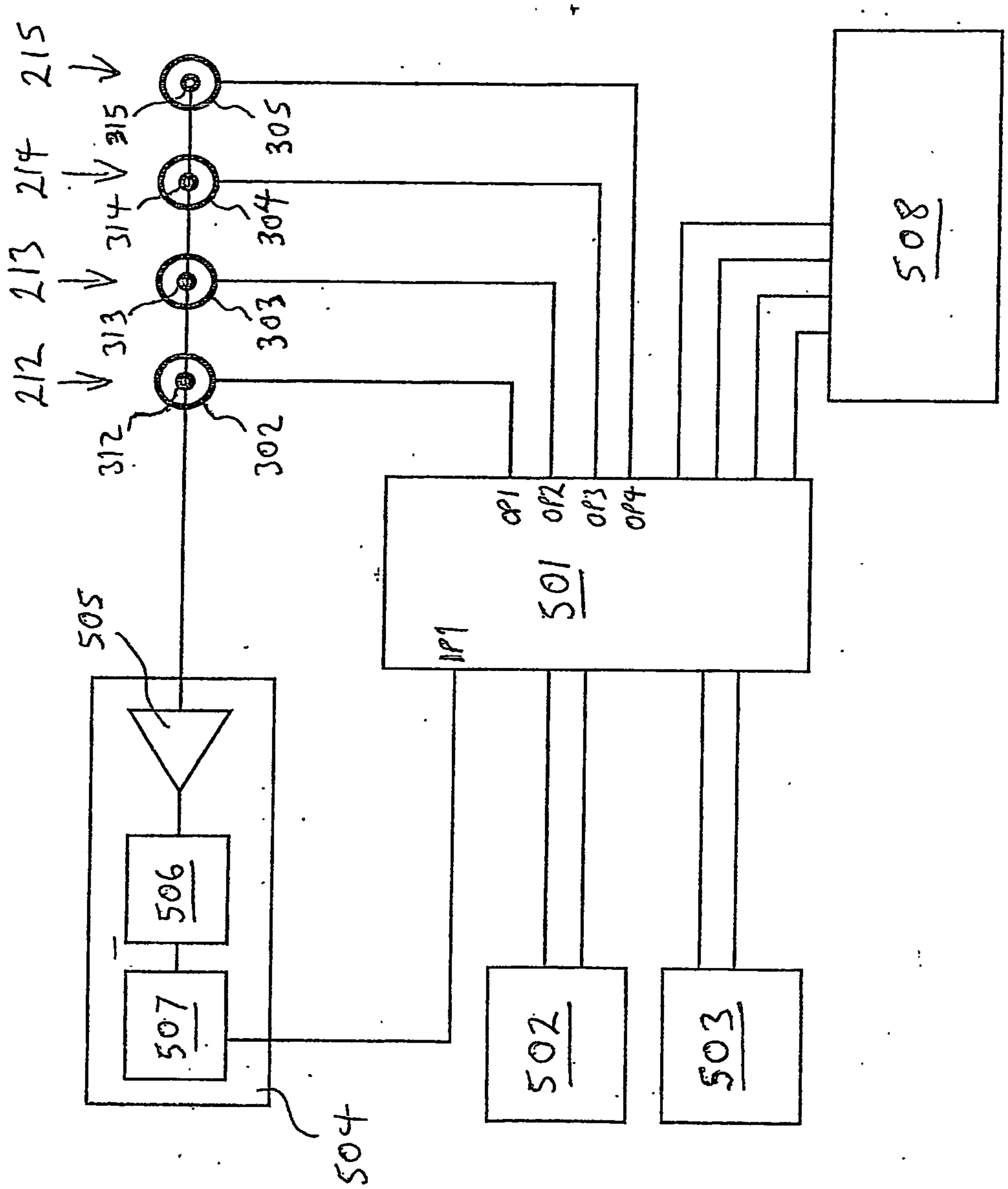
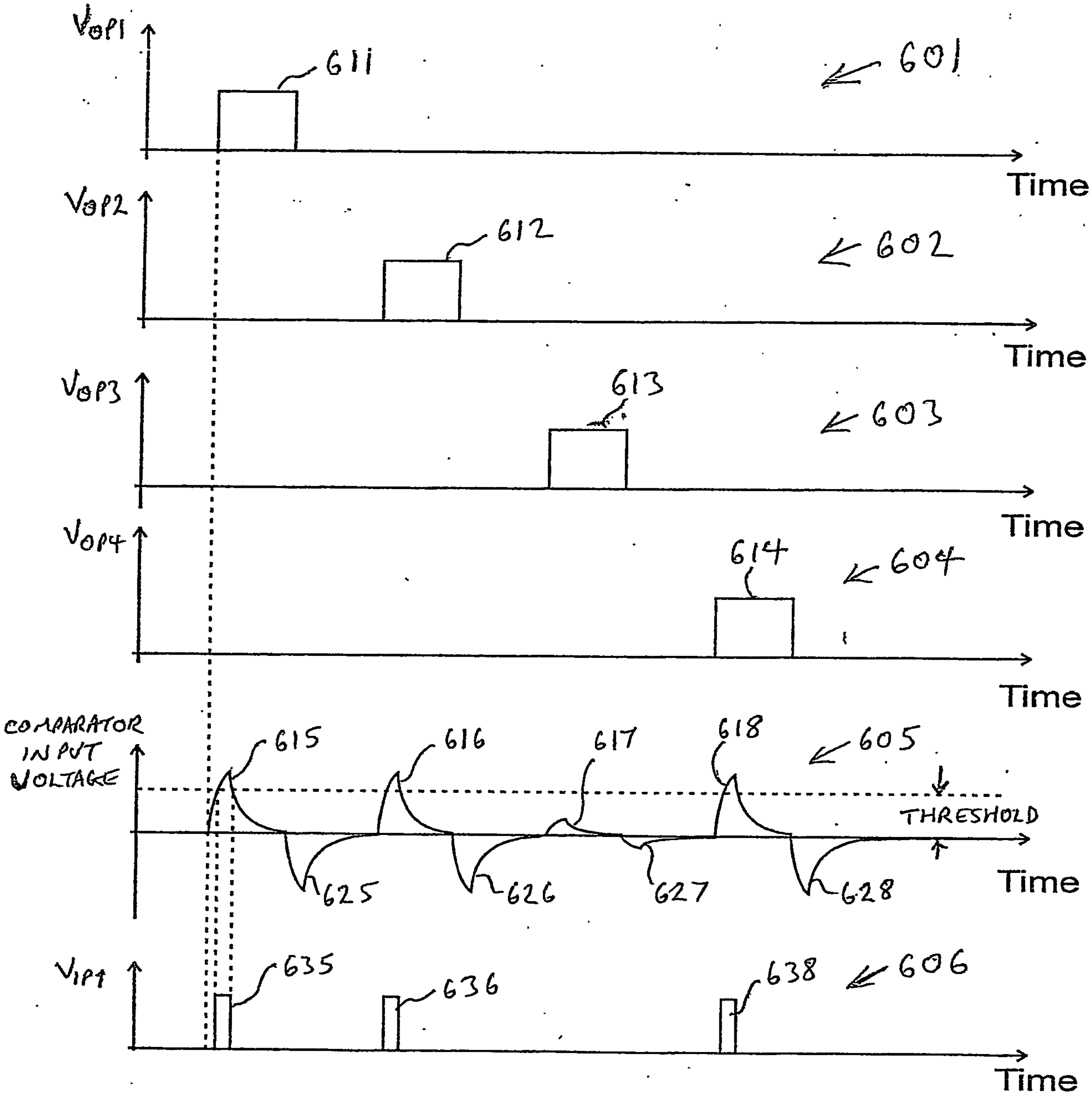

212
213
214
215
312
313
314
315
302
303
304
305
501
OP1
OP2
OP3
OP4
IP1
502
503
504
505
506
507
508

Fig. 5



V_{OP1}
611
601
Time
V_{OP2}
612
602
Time
V_{OP3}
613
603
Time
V_{OP4}
614
604
Time
COMPARATOR INPUT VOLTAGE
615
616
617
618
605
THRESHOLD
625
626
627
628
Time
V_{IP1}
635
636
638
606
Time

Fig. 6

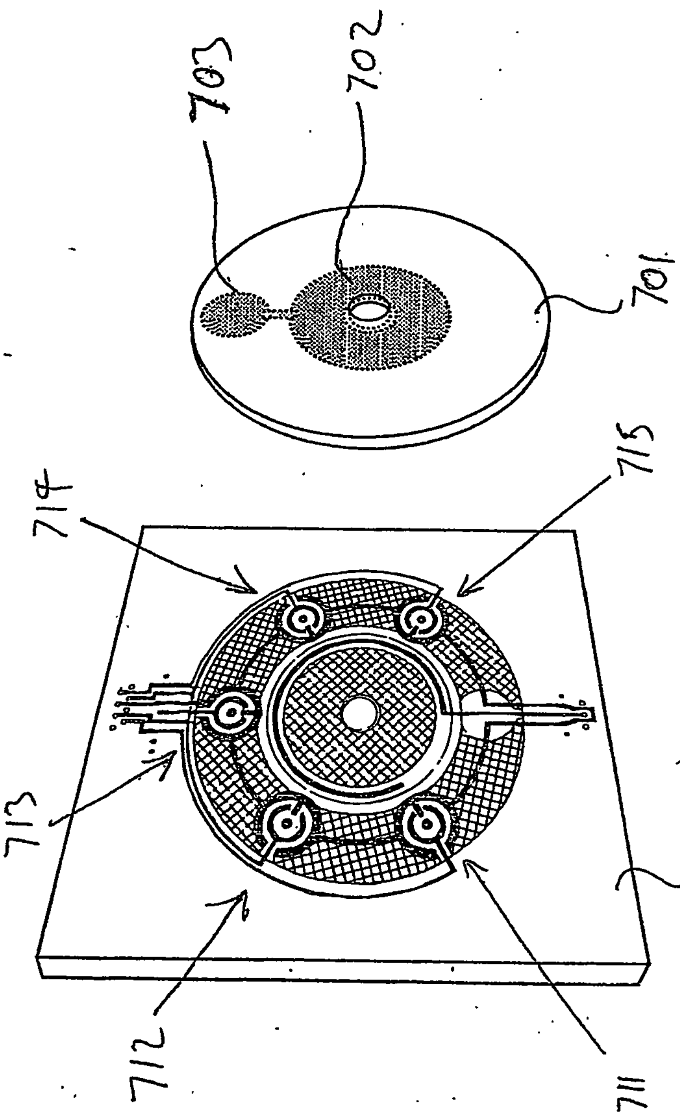


Fig. 7

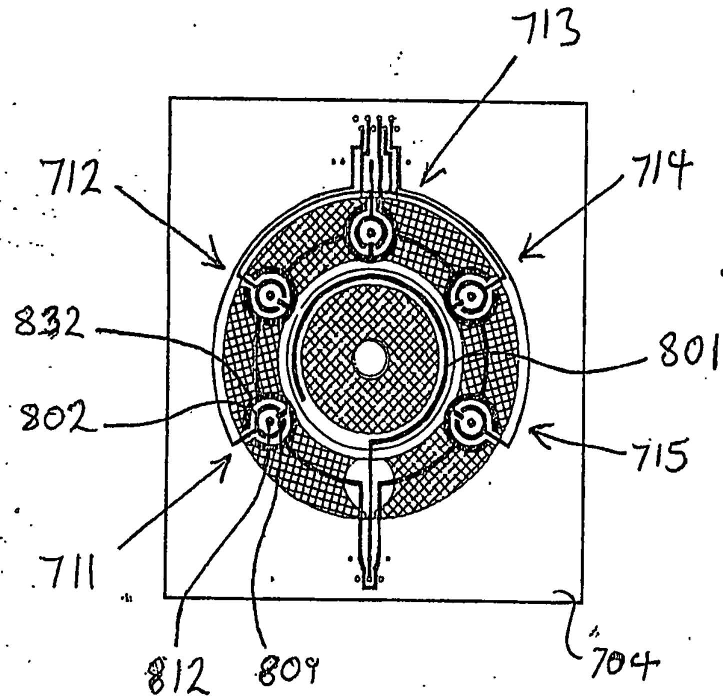

713
712
714
832
801
802
715
711
812
809
704

Fig. 8A

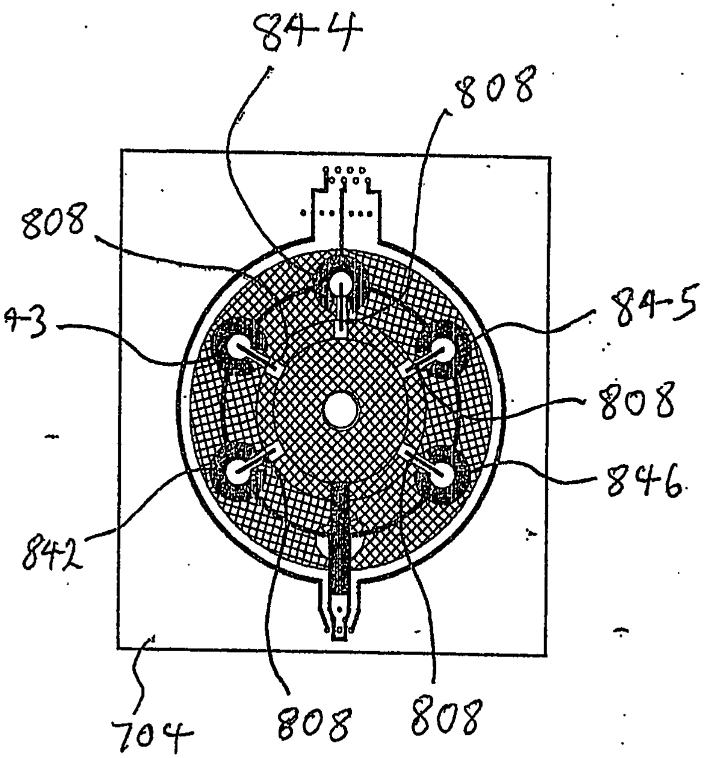

844
808
808
843
845
808
842
846
704
808
808

Fig. 8B

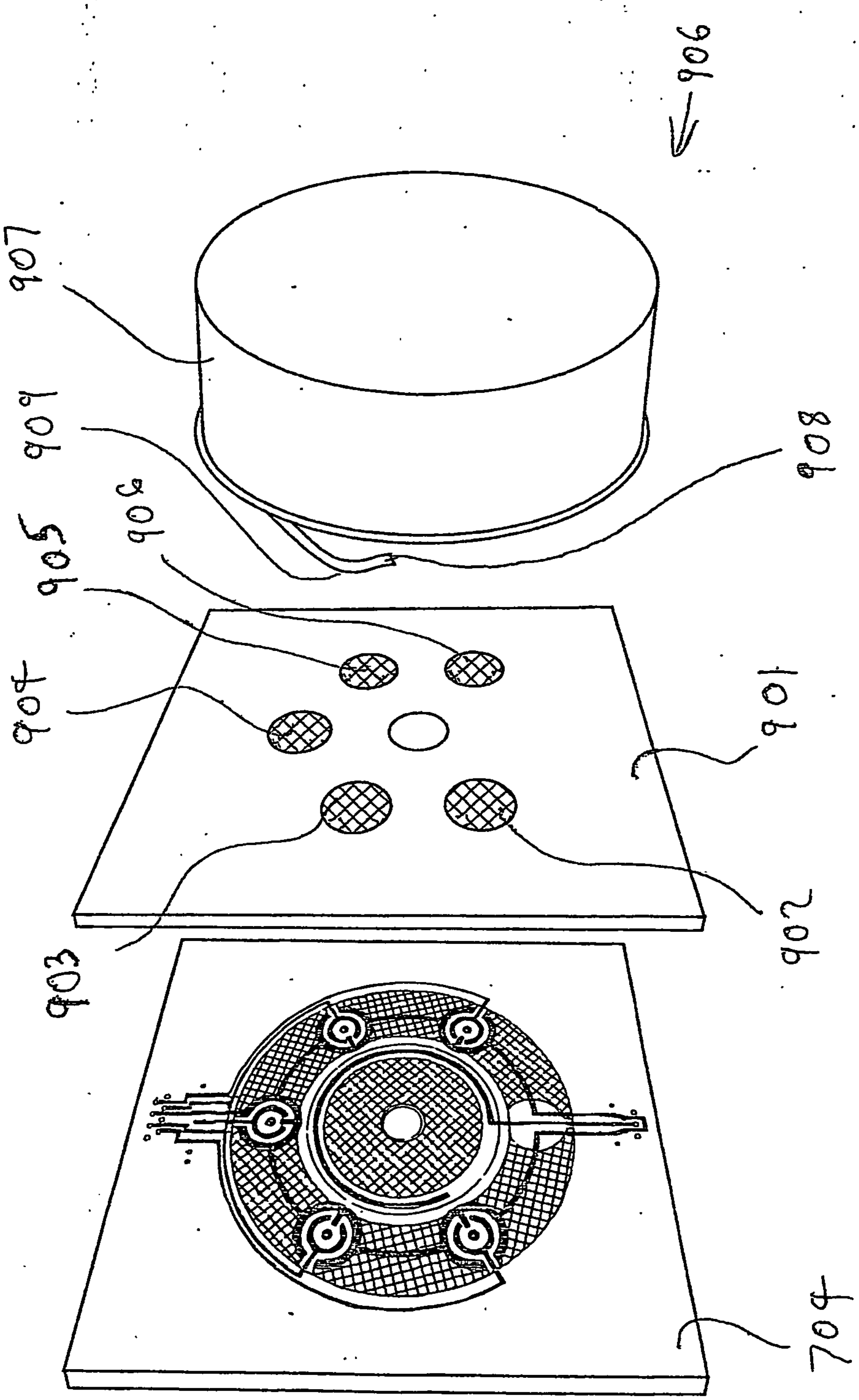


Fig. 9

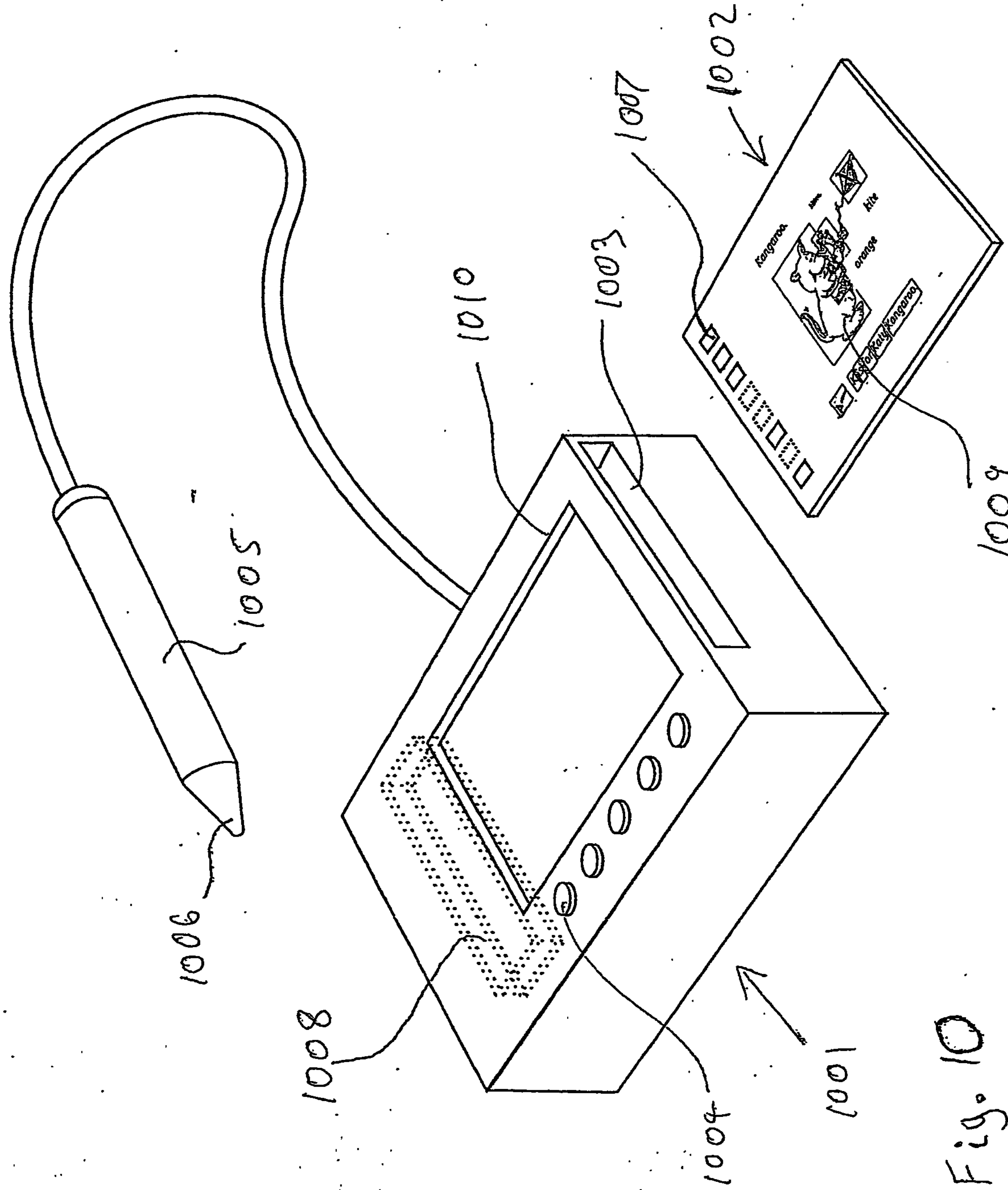

1001
1002
1003
1004
1005
1006
1007
1008
1009
1010
Kangaroo
orange
kite

Fig. 10

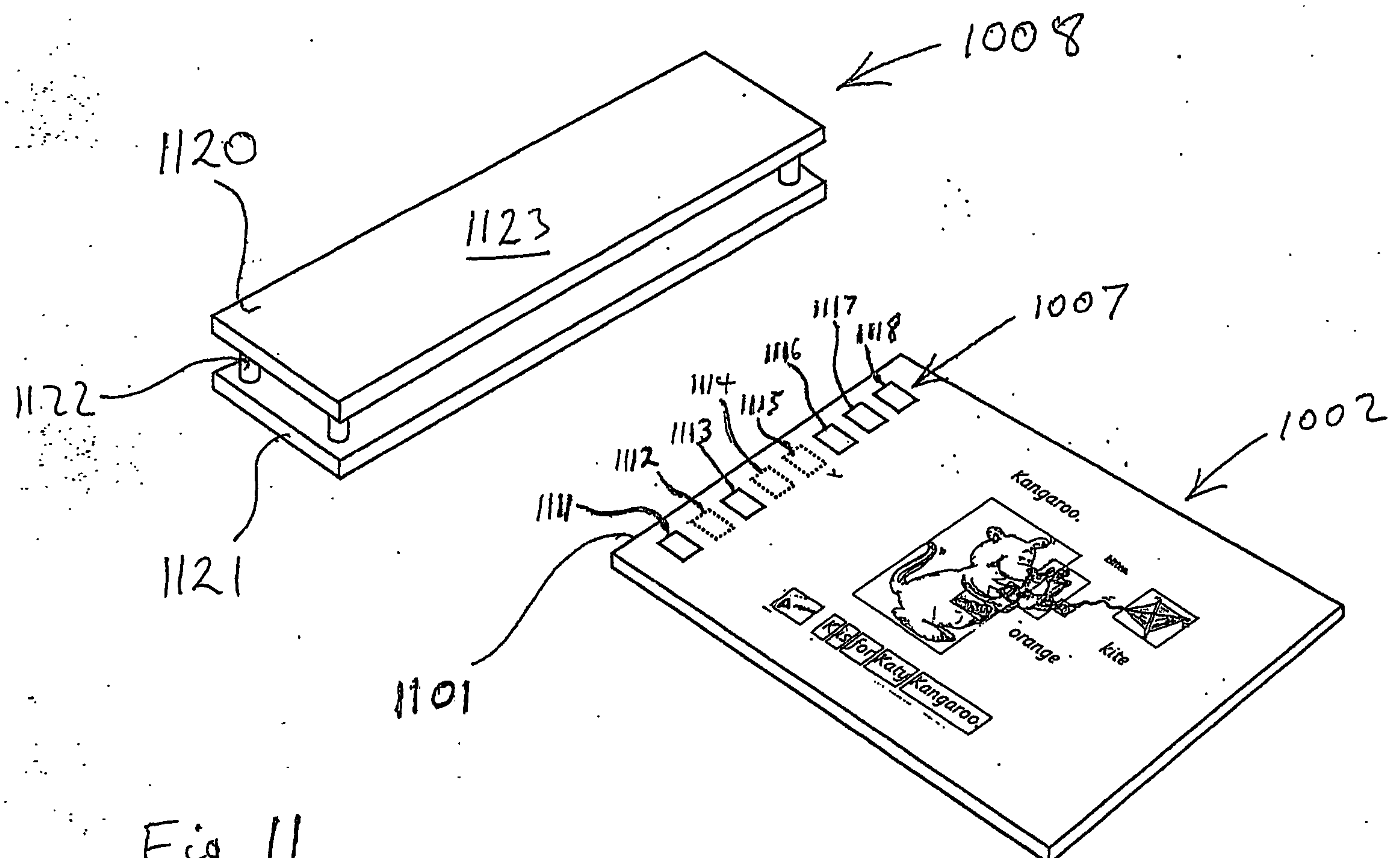

1008
1123
1120
1122
1121
1007
1117
1118
1116
1114
1115
1113
1112
1111
1101
1002
Kangaroo.
orange
kite
K is for Katy Kangaroo.

Fig. 11.

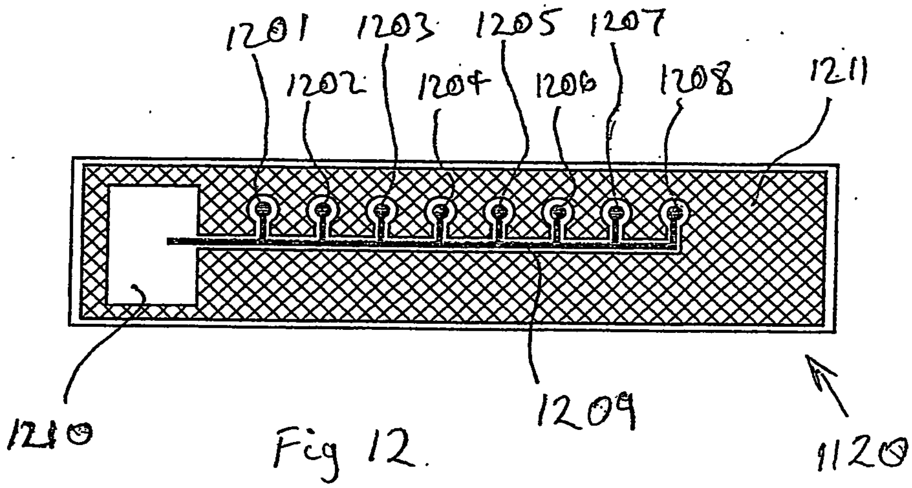

1201
1203
1205
1207
1202
1204
1206
1208
1211
1210
1209
1120

Fig 12

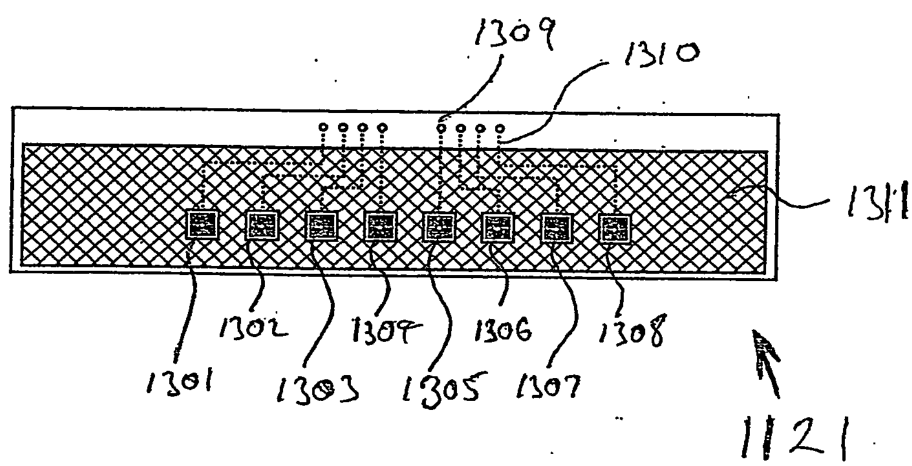

1309
1310
1311
1302
1304
1306
1308
1301
1303
1305
1307
1121

Fig. 13

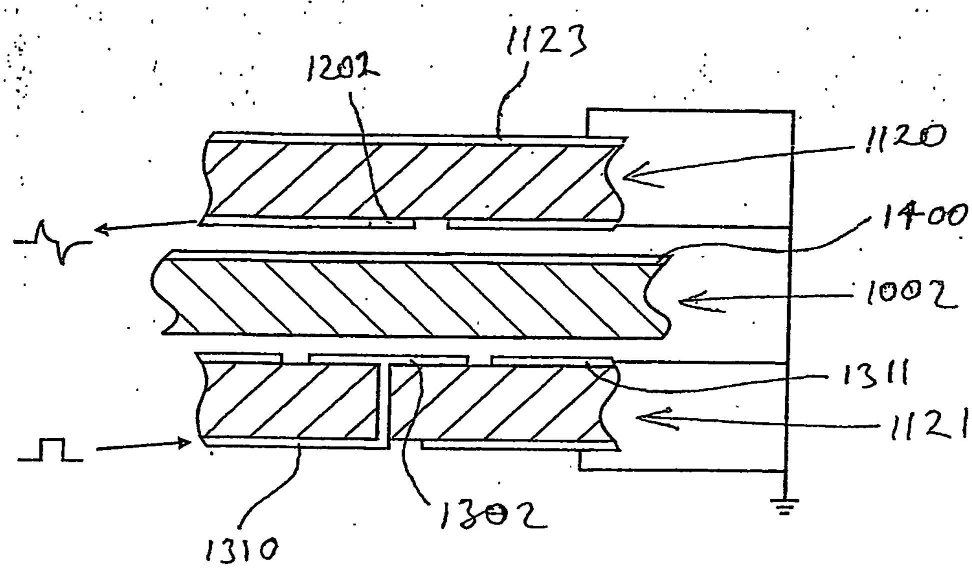


Fig. 14A

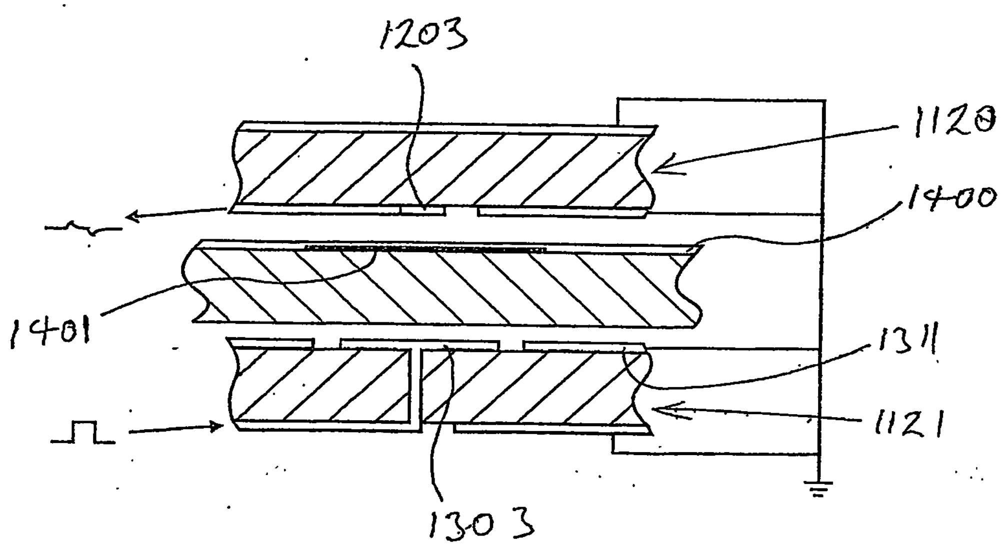


Fig. 14B

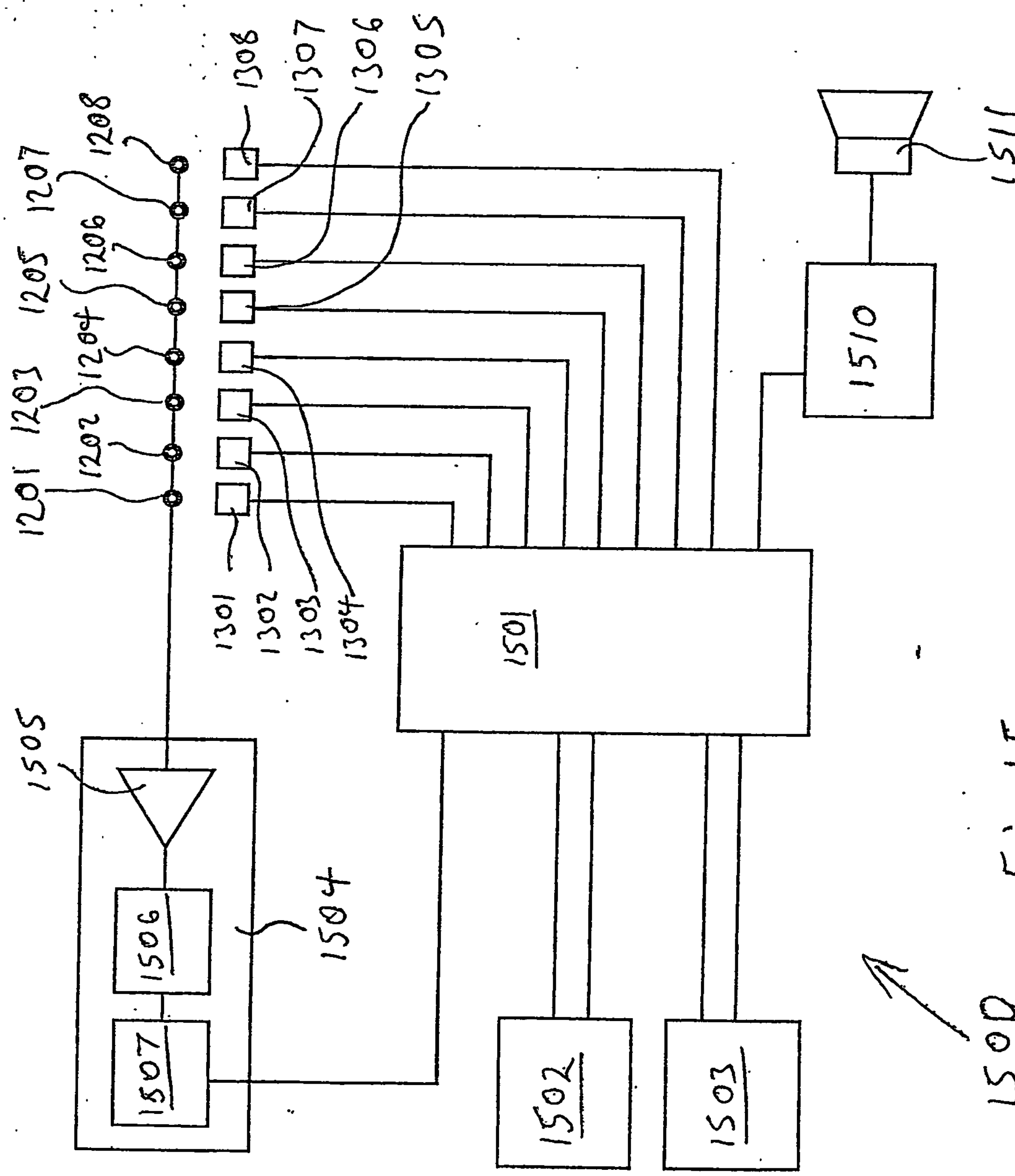

1201
1202
1203
1204
1205
1206
1207
1208
1301
1302
1303
1304
1305
1306
1307
1308
1501
1502
1503
1504
1505
1506
1507
1510
1511
1500

Fig. 15

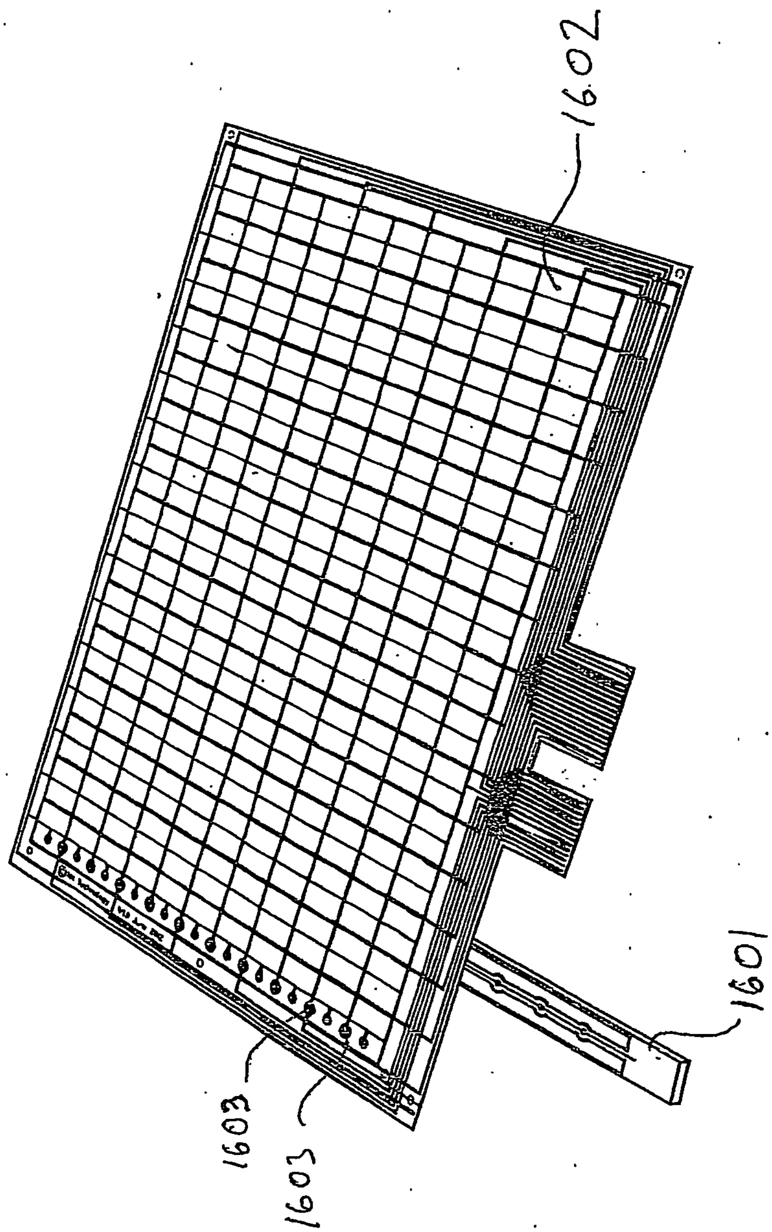


Fig. 16.

PCT Application
GB0304709